Compound Semiconductor Devices for Space Applications

Abstract

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The recent growth of the compound semiconductor industry has resulted in substantial improvements in processing methods, fabrication yield, and overall quality of commercially viable compound semiconductor devices. This coupled with large volume production and the utilization of statistical process control has greatly reduced the infant mortality population without having to impose traditional high reliability part specifications. However, reproducibility of a product does not guarantee reliability in the intended application. For critical space applications where the success or failure of a mission hinges on the lifetime and performance of a single device; it is critical that all aspects of the reliability and the various known failure modes and mechanisms be addressed prior to the insertion of the component in the application.

The selection and application of microelectronic components in high reliability space systems requires knowledge of the component design, fabrication process, and applicable tests. In addition, reliability analysis and detailed knowledge of the application environment is necessary in order to determine the suitability of the selected component for the application. These issues are of particular importance for the application of compound semiconductor devices in high reliability systems due to the need for the utilization of large numbers of these devices at the upper limit of their performance and stress capabilities.

The user of compound semiconductor devices must gain an understanding of not only the technology performance capabilities but also of the limitations of the technology and must employ methods to utilize it in a reliable fashion. The user must also understand that many of the failure mechanisms associated with silicon devices do not apply to GaAs and other compound semiconductors, and new device structures bring new failure mechanisms. In addition, many of the traditional assumptions for mean-time failure rate predictions do not hold for those new devices. Thus, today's high reliability user must be more aware of measurement based predictions of long term failure rate over calculation based predictions.

This paper will provide a description of the reliability and qualification issues related to the application of compound semiconductor devices in critical space systems. A discussion of common failure mechanisms, radiation effects and other reliability concerns is provided along with a discussion of methods for technology qualification for high reliability space applications.